Some Observations on the Ecology and Behavior of *Lucapinella callomarginata*

BY

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(Plate 16; 1 Text figure)

INTRODUCTION

McLean (1967) in his revision of the West American species of *Lucapinella* reported *Lucapinella callomarginata* (Dall, 1871) from the intertidal: "on the underside of rocks and on pilings near aggregations of *Mytilus edulis* in bays and channels in southern California. It has not been collected in the sub-littoral zone." No report other than this exists as to the habitat of this species, nor is there any description of the general biology of this organism. During the late summer of 1967, while dredging in the main channel leading to upper Newport Bay, California, I found 2 *L. callomarginata* in a radically different niche – the mud-flat sponge *Tetilla mutabilis* de Laubenfels, 1930. Subsequent collections and laboratory observations have served to confirm and extend this finding.

COLLECTIONS AND PRELIMINARY OBSERVATIONS

Dredging runs, made parallel to the northern shore of the channel about 300 yards east of the Route 101 bridge in about 10 to 15 feet of water, yielded a large number of *Tetilla* and 2 limpets were found tightly embedded in one of them. The importance of this find was not realized at the time, so no further search was made for limpets. The 2 limpets were brought back to the laboratory for identification and kept isolated in a running sea-water aquarium for 2 weeks before a fresh sponge was provided. The animals moved under the sponge and burrowed up and into it.

A second collection was made some weeks later at the same location by raking sponges by hand and a total of 9 limpets was recovered from 15 sponges. In most cases, if one limpet was found in a sponge, others would be present. Three limpets were placed on one of the sponges brought back to the laboratory at this time and it was used for the photographs in Plate 16.

A third collection was made at a small marina just east of the bridge, where, at low tide, sponges could be raked by hand in from 3 to 5 feet of water. Both *Tetilla* and a massive, branched, yellow sponge (tentatively identified as a species of *Halichondria*) were found, but there were only 3 limpets in about 30 specimens of *Tetilla*. All of these were found in one sponge. This particular *Tetilla* was highly irregular in form with 4 large oscula, whereas the vast majority of the others was more regular, with a single central osculum (Plate 16, Figure 5). The *Halichondria* (?) contained no limpets.

A fourth collection was made from the pilings under the bridge in an attempt to recover animals in the habitat described by McLean. A single limpet was found here away from any sponge. This animal was brought back to the laboratory alive for analysis of the contents of the fecal pellets.

EXTERNAL MORPHOLOGY OF *Lucapinella callomarginata*

Figures 1 to 4, Plate 16, are photographs taken of a representative specimen of *Lucapinella callomarginata*. Figure 1 is a dorsal view, showing the highly sculptured shell, the fringed mantle, the excurrent siphon set off by an anterior and posterior set of 6 or more large, fleshy papillae, and the massive posterior portion of the foot. Figure 2 shows the same animal from the side. The ante-

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rior end is to the right in the figure. The fringed mantle extends just over the edge of the shell and down over the foot for a distance of 2 to 4 mm. The portion of the mantle shielding the head is considerably broader than the portion that extends over the foot. Each of the mantle papillae on the upper portion of the flap appears to line up with a shell ridge. Many times two anterior portions of the mantle are held up, forming fan-shaped openings on either side of the head at about the position of the tentacles. This can be seen from above in the upper lefthand animal in Figure 4, Plate 16 and is probably used as a method of increasing the incurrent water flow. The excurrent siphon is extendable to at least 5 mm above the shell surface at the aperture. An animal with its siphon extended is shown in Plate 16, Figure 6. The shell of this animal has been described (McLean, 1967).

Figure 3, Plate 16, shows an animal resting in the lower corner of an aquarium. The lower mantle flap has been lifted, displaying the proboscis, head tentacle, and a line of epipodial tentacles decreasing in size posteriorly. The obvious fold in the foot is not a permanent structure. Figure 4, Plate 16, shows 6 animals found during one of the collecting trips and demonstrates the variability in shell and body color and the differences in spot patterns on the surface of the foot. In general, the over-all color of the flesh is an orange-brown to orange-red. The larger scattered spots on the foot range from darker shades of brown to black. The brown or reddish color tended to fade when the animals were kept away from sponges.

FEEDING BEHAVIOR

General observations were made of the feeding behavior of *Lucapinella callomarginata*. The animals appear to attack *Tetilla* anywhere along the sides but seem to prefer the area around the base where the sponge is attached to the mud (Plate 16, Figure 6). The limpet grazes on the surface and forms a cavity which is eventually enlarged to encompass the entire foot of the animal (Plate 16, Figure 8). The limpet crawls forward, burying itself in the sponge, evidently eating its way through. It may be covered by subsequent growth of the sponge around and over it (Plate 16, Figures 5, 6). As the limpet moves forward in the sponge, it creates a groove, one of which was 4 inches long. In 2 cases, limpets were seen to enter the sponge by way of the large osculum and commence feeding while in it. No experiments were done to see if the limpets were attracted to the sponge.

The fecal pellets of limpets grazing on *Tetilla* were collected and examined. They contained sponge spicules and unidentifiable debris. Several of the animals were then starved for a few days and presented a number of sponges in isolation to determine if *Tetilla* was the sole food. In each situation fecal pellets were collected and a search was made for sponge spicules. The types found in the feces were compared with the spicules obtained from the sponge on which the animal was feeding. Text figure 1 summarizes the results when limpets were exposed to the sponges *Tetilla mutabilis, Hymeniacidon synapium* de Laubenfels, 1930 (Plate 16, Figure 10) and the specimen of *Halichondria* (?) (Plate 16, Figure 9) mentioned earlier. As the figure shows, the limpets attacked all 3 sponges, and in each case the spicules in the feces, though somewhat broken up, matched those of the sponge endosome. Also shown (G) are the spicules found in the fecal pellets of the one limpet taken from the pilings. This assemblage, not found in any of the 3 sponges tested, is probably a conglomerate. The tylostyle is probably from a sponge in the family Clionidae while the prodiaene may be from the ectosome of *Tetilla* (de Laubenfels, 1932). Indications are, then, that sponges of the order Demospongia are eaten and the limpets do not restrict their diet to a single genus. It is also evident that the limpets can do severe damage to the sponges they attack (Plate 16, Figure 9).

Since the limpets are often found in areas away from sponges (MacGinitie, personal communication), it is possible that these animals are grazers as well as predators. During a series of observations of isolated limpets it was noticed that portions of the surfaces of the aquarium had been cleaned of the coating of debris. Eventually, one limpet was observed through the glass wall of an aquarium to be grazing on the surface. In contrast to *Tegula* or *Haliotis*, the stroke of the radula was very short, which might be an indication that it is designed more for tearing than for scraping. Confirming evidence of feeding on algae was obtained from the feces of the limpet found on the bridge piling. Fragments of plant material were seen along with the spicules. No diatom tests were noted, though there was much unidentifiable debris present.

Although the animals may remain in one *Tetilla* for a considerable period of time, they must eventually exhaust the resources of their prey and have to find another sponge. Therefore, observations were made on the behavior of limpets placed on a soft, sandy-mud substrate. Surprisingly, the animals had little difficulty, making almost as rapid progress as they do on glass.

Initially, the anterior portion of the foot is splayed out in front of the animal, forcing itself into the mud. At the same time, the proboscis is extended forward as a narrow tube, sliding on the upper surface of the foot. When it reaches its maximum extension, the tip expands and remains expanded as the proboscis is drawn back

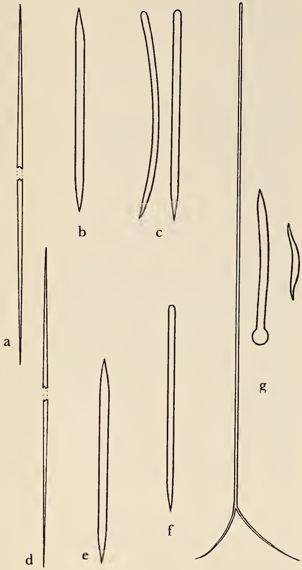

Figure 1
(<— adjacent column)

(not to scale)

A. Tornote from the endosome of *Tetilla mutabilis*. The longest spicule seen measured about 33 mm in length while the smallest measured 8 mm.
B. Oxea from the endosome of the yellow sponge thought to be *Halichondria*. The largest measured 3.2 mm in length, 0.8 mm in width.
C. Style from the endosome of *Hymeniacidon synapium* (2 views). The largest measured 0.75 mm in length, 165μ in width.
D. Tornote from the fecal pellets of a specimen of *Lucapinella callomarginata* fed only on *Tetilla mutabilis*. This was the only type of spicule found.
E. Oxea from the fecal pellets of a specimen of *Lucapinella callomarginata* fed only on *Halichondria* (?). This was the only type of spicule found.
F. Style from the fecal pellets of a specimen of *Lucapinella callomarginata* fed only on *Hymeniacidon synapium*. This was the only type of spicule found.
G. Representative assemblage of spicules found in the fecal pellets of a specimen of *Lucapinella callomarginata* collected on a piling in Newport Bay, California. Shown are (from left to right) a prodiaene, a tylostyle (0.15 mm length $\times$ 40μ width) and an oxea (100μ length $\times$ 5μ width).

toward the head. The animal then glides forward. Posteriorly, the foot is spread out to at least twice the length of those shown in Plate 16, Figure 4, and the active secretion of mucus is in evidence as a trail of compacted mud behind the animal. In this manner, the limpet actively burrows along, though it was not seen to move into the mud above the level of the shell. The mantle flap is maximally lifted in the head tentacle areas and these openings may be pressed posteriorly or even obliterated by the mud piling up in front of and beside the animal. The epipodial tentacles are maximally extended. Small masses of sediment particles taken into the mantle cavity are ejected periodically through the excurrent siphon, which is also maximally extended.

Explanation of Plate 16

Figure 1: A specimen of *Lucapinella callomarginata* from above. The smallest scale division is 1 mm.
Figure 2: The same animal in side view. Same scale as Figure 1.
Figure 3: The same animal from below. The scale is in millimeters.
Figure 4: Six specimens of *Lucapinella callomarginata*.
Figure 5: A large specimen of *Tetilla mutabilis* in the "regular massive" form. The dish on which the sponge rests measures six inches in diameter. The arrow points to the position of a limpet. Two more limpets are in the sponge but hidden from view. Scale equals 25 mm (Figures 6 to 10 on same scale).
Figure 6: The same sponge in side view. The long root attachment system is clearly shown. The arrow indicates the position of the limpet. The shell aperture and siphon of the animal are visible.
Figure 7: The same view with sponge overgrowth cleared away.
Figure 8: The limpet has been pulled out of the sponge. The large cavity left by the foot can be seen, as well as a thin layer of sponge still attached to the foot (arrow). The extended tentacles of the limpet can also be made out.
Figure 9: The same sponge after three weeks. Four possible centers of regeneration have been created. The two finger-like structures in the foreground are portions of the yellow sponge thought to be a species of *Halichondria*.
Figure 10: A large specimen of *Hymeniacidon synapium* collected in four feet of water at low tide.

Figure 1

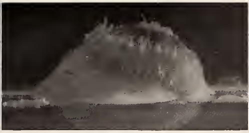

Figure 2

Figure 3

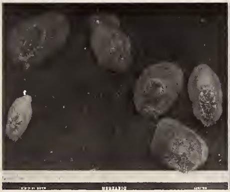

Figure 4

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

Figure 10